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EIGHTH MONTHLY PROGRESS REPORT ON DEVELOPMENT AND TESTING OF ELECTROLYTE MATRIX COMBINATIONS FOR MERCURY-POTASSIUM FUEL CELL

N64-18287
CODE-1
CR-53352

Eighth Monthly Progress Report (12 July–12 August 1963)

[X] OTS
[2]

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(NASA CONTRACT NASw-476)

DATE SUBMITTED: 26 August 1963

5p (cy)

OTS PRICE
XEROX $ 1.10 hc
MICROFILM $ 0.80 mf

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(NASA CR-53352)
EDR-3530

PROGRESS OF WORK DURING REPORTING PERIOD

As a result of a decision made at a Program Status Meeting, all effort has been turned to the fine grain composite development. Figure 1 shows the revised milestone chart presented at the meeting. One cell test with a coarse grain composite occurred prior to the decision and is reported here.

Greater effort will now be applied to the development of a good composite. This work will include further investigations into preparation techniques and also effort in the fabrication of 4 in. x 1/8 in. disks for use in large cells.

Small Cell Testing

Two small cells were tested during this period. One cell was the last of the coarse grain composites and was designated NASA-IV. The other cell, NASA-V, was the initial unit of the second generation fine grain composites to be tested.

Cell NASA-IV was built up from a 33% electrolyte coarse grain composite. The total test time was 2 hours 40 minutes. This cell did not reach one volt during the loading and operating procedure. Therefore, it appeared to be in a shorted condition. However, voltage never dropped to zero prior to shutdown.

Cell NASA V was intended to use a 56.5% electrolyte fine grain composite. This specimen was oversize in thickness, and it warped during processing. Because the composite was too large for assembly in a cold cell, it consequently broke and was replaced by a green composite. (The green composite is one which has not been baked after cold pressing.)

It was the intention of the investigation to bakeout in the cell operating position and thereby eliminate the need for temperature cycling. After this cell was closed and allowed to set up over night, mercury was added. A short was indicated immediately as the Hg made contact with the matrix. Also, Hg was detected on the potassium side of the cell. Posttest analysis showed

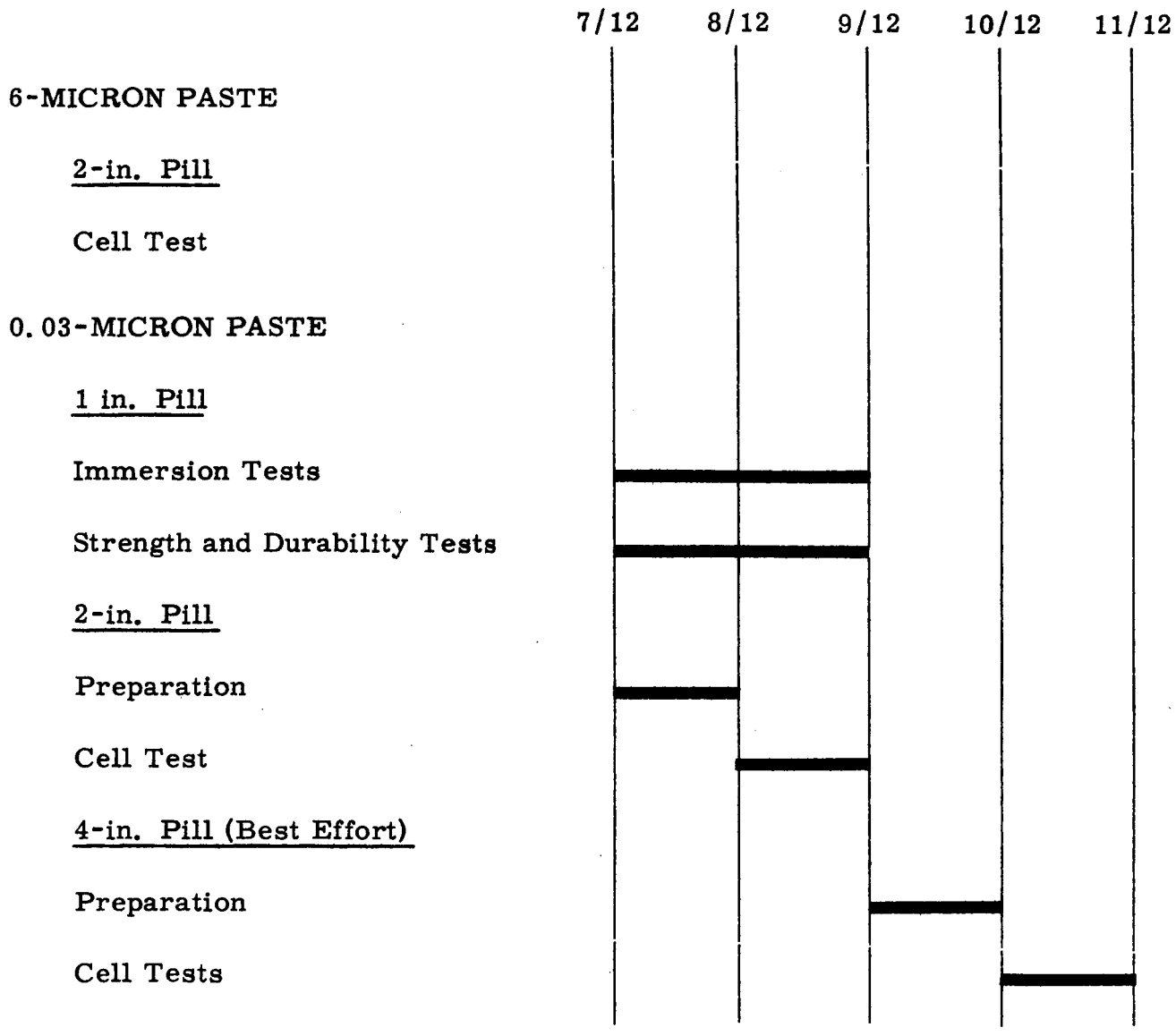

Figure 1. Revised Milestone Chart

that the green composite had not cured properly in this unsupported configuration and, as a result, broke under the head of Hg.

Composite Improvement Program

The following changes were made in an attempt to find a combination of materials and procedures that would eliminate cracking, bloating, and blistering.

1. A series of 1 in. dia x 1/8 in. specimens was made to evaluate variations in quality and strength resulting from changes in baking procedure, as follows:

   - Vacuum versus argon bake
   - Rapid cool versus slow cool
   - Nickel versus gold baking support

   No significant improvements were made, but the best overall combination was observed to be baking under Argon, on gold plate, using a slow cooling rate.

2. A new baking environment was tried. The composite green specimen was packed in a coarse grain MgO for the baking step. This was done to give even temperature distribution and eliminate metal contact during baking. The MgO powder is expected to desaturate the surface of the specimen, but future work will show the amount of desaturation and the correct overshoot of electrolyte content to get the desired end result.

Composite Fabrication

Seven batches of fine grain composites using light calcined MgO were prepared. These had electrolyte contents of 52.5, 55.5, 56.7, 58.2, 61.7, 63.0, and 69.3 percent. Strength and flowability tests have shown the normal trend of high strength with low saturation. The 69.3% electrolyte composite was highly fluid without strength.

Considerable difficulty of cracking was experienced with specimens made from these batches. This difficulty was the greatest single factor which held up cell testing. To overcome cracking, a new material was tried.

One batch of the fine electronic grade MgO is now being evaluated. Early results indicate that this material when used with the new bakeout method may give crack-free specimens.

WORK FOR NEXT REPORTING PERIOD

The following specific tasks are scheduled for the next reporting period.

1. Work will be done to further determine the properties of newly developed composites. Small cells using this composite will be run.

2. Quantities of the 2 in. x 1/8 in. specimens will be produced for an increased effort in testing.

3. Development effort will be turned to the solution of problems in the fabrication of 4 in. x 1/8 in. disks from fine grain composites.

CUMULATIVE MAN MONTHS EXPENDED

RESEARCH	21.5
SHOP	0.6
MATERIALS LABORATORY	16.5

BUDGET

RESEARCH	30 Man Months
SHOP	2 Man Months
MATERIALS LABORATORY	17 Man Months